CLAIMS

1. A multiple pulse single head laser comprising:

a) a laser cavity;

b) a lasing medium having a population inversion threshold for lasing located within said cavity ;

c) a modulator having an on and an off position located within said cavity in optical communication with said lasing medium;

d) a pumping source in optical communication with said lasing medium to provide electromagnetic radiation(EMR) to said lasing medium;

e) said modulator in said on position inducing a loss in said cavity sufficient to prevent lasing;

f) said lasing medium storing energy from said pumping source to create a population inversion in said lasing medium in excess of the lasing threshold of said lasing medium when said modulator is in said on position;

g) said modulator in said off position allowing lasing to occur in said cavity;

h) a controller in communication with said modulator to turn said modulator from said on position to said off position and vise versa; said controller

i) turning said modulator to said on position for a first period of time to store a first predetermined amount of energy in said lasing medium by creating a population inversion in said lasing medium in excess of the lasing threshold of said lasing medium;

ii) turning said modulator to said off position for a second predetermined period of time to allow lasing of said lasing medium to produce a first pulse;

iii) turning said modulator on before said population inversion in said lasing medium is completely depleted so that a second predetermined amount of energy remains stored in said lasing medium; said first pulse containing a first controlled amount of pulse energy;

iv) maintaining said modulator in said on position for a second predetermined period of time approximately equal to a preselected pulse separation;

v) turning said modulator to said off position for a third predetermined period of time to allow lasing of said lasing medium to provide a second pulse having a second controlled amount of pulse energy.

2. The multiple pulse single head laser according to claim 1 comprising said lasing medium having a fluorescent lifetime; said first and said second pulses having a time separation of less than 2 times the fluorescent lifetime of said lasing medium.

3. The multiple pulse single head laser according to claim 1 comprising said lasing medium having a fluorescent lifetime; said first and said second pulses having a time separation of less than the fluorescent lifetime of said lasing medium.

4. The multiple pulse single head laser according to claim 1 comprising said lasing medium having a fluorescent lifetime; said first and said second pulses

having a time separation of 10% or less the fluorescent lifetime of said lasing medium.

5. The multiple pulse single head laser according to claim 1 wherein said first pulse and said second pulse have about the same amount of pulse energy.

6. The multiple pulse single head laser according to claim 1 further comprising said controller

vi) turning said modulator on before said population inversion in said lasing medium is completely depleted so that a fourth predetermined amount of energy remains stored in said lasing medium; said second pulse containing a second controlled amount of pulse energy;

vii) maintaining said modulator in said on position for a fourth predetermined period of time, said fourth predetermined period of time approximately equal to a preselected pulse separation;

viii) turning said modulator to said off position for a fifth predetermined period of time to allow lasing of said lasing medium to provide a third pulse having a third controlled amount of pulse energy.

7. The multiple pulse single head laser according to claim 1 further comprising said pulses have about the same amount of pulse energy.

8. The multiple pulse single head laser according to claim 1 further comprising said laser has a repetition rate of 1 to 10 kHz.

9. The multiple pulse single head laser according to claim 1 wherein said lasing medium is an Nd:YAG lasing crystal.

10. The multiple pulse single head laser according to claim 1 wherein said lasing medium is an Nd:YLF crystal and said modulator is turned on in iii) before said population inversion in said lasing medium reaches said lasing threshold.

11. The multiple pulse single head laser according to claim 10 wherein said first and said second pulses have a pulse separation of from 0.5μs to 500μs.

12. The multiple pulse single head laser according to claim 10 wherein said first and said second pulses have a pulse separation of from 1μs to 200μs.

13. The multiple pulse single head laser according to claim 11 wherein said first and second pulse have a pulse energy of 1mj to 40mj.

14. The multiple pulse single head laser according to claim 11 wherein said first pulse and said second pulse have a pulse energy of 3mj to 25 mj.

15. The multiple pulse single head laser according to claim 11 further comprising said first pulse and said second pulse have about the same pulse energy.

16. The multiple pulse single head laser according to claim 11 further comprising said controller

vi) turning said modulator on before said population inversion in said lasing medium reaches said lasing threshold so that a fourth predetermined amount of energy remains stored in said lasing medium ; said second pulse containing a second controlled amount of pulse energy ;

vii) maintaining said modulator in said on position for a fourth predetermined period of time, said fourth predetermined period of time approximately equal to a preselected pulse separation;

viii) turning said modulator to said off position for a fifth predetermined period of time to allow lasing of said lasing medium to provide a third pulse having a third controlled amount of pulse energy.

17. The multiple pulse single head laser according to claim 11 further comprising said first pulse , said second pulse and said third pulse have about the same pulse energy.

18. The multiple pulse single head laser according to claim 17 wherein said first , said second and said third pulses have a pulse separation of from 0.5μs to 500μs.

19. The multiple pulse single head laser according to claim 18 wherein said first, said second and said third pulses have a pulse separation of from 1μs to 200μs.

20. The multiple pulse single head laser according to claim 11 wherein said controller includes a microprocessor controller.

21. The multiple pulse single head laser according to claim 1 wherein in iii) said modulator is turned on before the population inversion falls below the lasing threshold.

22. The multiple pulse single head laser according to claim 6 wherein in iii) and vi) said modulator is turned on before the population inversion falls below the lasing threshold.

23. A method of providing multiple laser pulses from a single laser:

a) forming a laser cavity; said laser cavity including

i) a lasing medium having a population inversion threshold for lasing and;

ii) a modulator having an on and an off position;

b) pumping said lasing medium to provide electromagnetic radiation(EMR) to said lasing medium;

c) turning said modulator on to induce a loss in said cavity sufficient to prevent lasing ;

d) storing a first predetermined amount of energy in said lasing medium when said modulator is turned on by creating a population inversion in said lasing medium in excess of the lasing threshold of said lasing medium ;

e) turning said modulator off for a first predetermined period of time to allow lasing of said lasing medium to provide a first pulse ;

f) turning said modulator on before said population inversion in said lasing medium is completely depleted so that a second predetermined amount of energy remains stored in said lasing medium ; said first pulse containing a first controlled amount of pulse energy ;

g) said modulator inducing a loss in said cavity sufficient to prevent lasing;

h) maintaining said modulator in said on position for a second predetermined period of time approximately equal to a preselected pulse separation;

i) turning said modulator off for a third predetermined period of time to allow lasing of said lasing medium to provide a second pulse having a second controlled amount of pulse energy.

24. The method of providing multiple laser pulses from a single laser according to claim 1 further comprising said lasing medium having a fluorescent lifetime; said first and said second pulses having a time separation of less than 2 times the fluorescent lifetime of said lasing medium.

25. The method of providing multiple laser pulses from a single laser according to claim 23 further comprising said lasing medium having a fluorescent lifetime; said first and said second pulses having a time separation of less than 1 time the fluorescent lifetime of said lasing medium.

26. The method of providing multiple laser pulses from a single laser according to claim 23 further comprising said lasing medium having a fluorescent lifetime; said first and said second pulses having a time separation of 10% or less the fluorescent lifetime of said lasing medium.

27. The method of providing multiple laser pulses from a single laser according to claim 23 wherein said first pulse and said second pulse have about the same amount of pulse energy .

28. The method of providing multiple laser pulses from a single laser according to claim 23 further comprising:

j) turning said modulator on before said population inversion in said lasing medium is completely depleted so that a fourth predetermined amount of energy remains stored in said lasing medium ; said second pulse containing a second controlled amount of pulse energy ;

k) maintaining said modulator in said on position for a fourth predetermined period of time, said fourth predetermined period of time approximately equal to a preselected pulse separation;

l) turning said modulator to said off position for a fifth predetermined period of time to allow lasing of said lasing medium to provide a third pulse having a third controlled amount of pulse energy.

29. The method of providing multiple laser pulses from a single laser according to claim 23 further comprising said pulses have about the same amount of pulse energy.

30. The method of providing multiple laser pulses from a single laser according to claim 23 further comprising said laser has a repetition rate of 500 to 5000 kHZ.

31. The method of providing multiple laser pulses from a single laser according to claim 23 wherein said lasing medium is an Nd:YAG lasing crystal.

32. The method of providing multiple laser pulses from a single laser according to claim 23 wherein said lasing medium is an Nd:YLF lasing crystal and said modulator is turned on in f) before said population inversion in said lasing medium reaches said lasing threshold.

33. The method of providing multiple laser pulses from a single laser according to claim 32 wherein said first and said second pulses have a pulse separation of from 0.5μs to 500μs.

34. The method of providing multiple laser pulses from a single laser according to claim 32wherein said first and said second pulses have a pulse separation of from 1μs to 200μs.

35. The method of providing multiple laser pulses from a single laser according to claim 33 wherein said first and second pulse have a pulse energy of 1mj to 40mj.

36. The method of providing multiple laser pulses from a single laser according to claim 33 wherein said first pulse and said second pulse have apulse energy of 3mj to 25mj.

37. The multiple pulse single head laser according to claim 33 further comprising said first pulse and said second pulse have about the same pulse energy.

38. The multiple pulse single head laser according to claim 33 further comprising:

j) turning said modulator on before said population inversion in said lasing medium reaches said lasing threshold so that a fourth predetermined amount of energy remains stored in said lasing medium; said second pulse containing a second controlled amount of pulse energy;

k) maintaining said modulator in said on position for a fourth predetermined period of time, said fourth predetermined period of time approximately equal to a preselected pulse separation;

l) turning said modulator to said off position for a fifth predetermined period of time to allow lasing of said lasing medium to provide a third pulse having a third controlled amount of pulse energy.

39. The method of providing multiple laser pulses from a single laser according to claim 33 further comprising said first pulse , said second pulse and said third pulse have about the same pulse energy.

40. The method of providing multiple laser pulses from a single laser according to claim 38 wherein said first, said second and said third pulses have a pulse separation of from 0.5μs to 500μs.

41. The method of providing multiple laser pulses from a single laser according to claim 40 wherein said first , said second and said third pulses have a pulse separation of from 1μs to 200μs.

42. The method of providing multiple laser pulses from a single laser according to claim 23 wherein in f) said modulator is turned on before the population inversion falls below the lasing threshold.

43. The method of providing multiple laser pulses from a single laser according to claim 28 wherein in f) and j) said modulator is turned on before the population inversion falls below the lasing threshold.

44. The method of providing multiple laser pulses from a single laser according to claim 23 wherein said pumping source is a continuous pumping

source, the amount of energy in said lasing medium increasing to a third predetermined amount of energy by increasing the population inversion in said lasing medium in excess of the population inversion of iii) .

45. The method of providing multiple laser pulses from a single laser according to claim 23 wherein said modulator is turned on and off multiple times to produce four(4) or more pulses .

46. The method of providing multiple laser pulses from a single laser according to claim 23 wherein said modulator is turned on and off multiple times to produce four(4) to eight(8) pulses.

47. The multiple pulse single head laser according to claim 1 wherein said pumping source is a continuous pumping source, the amount of energy in said lasing medium increasing to a third predetermined amount of energy by increasing the population inversion in said lasing medium in excess of the population inversion of iii).

48. The multiple pulse single head laser according to claim 1 wherein said modulator is turned on and off multiple times to produce four(4) or more pulses.

49. The multiple pulse single head laser according to claim 1 wherein said modulator is turned on and off multiple times to produce four(4) to eight(8) pulses.

50. The multiple pulse single head laser according to claim 1 wherein said laser is a harmonic laser.

51. The multiple pulse single head laser according to claim 1 wherein said laser is intracavity harmonic laser.

52. The multiple pulse single head laser according to claim 51 wherein said laser is a second harmonic laser.

53. The multiple pulse single head laser according to claim 51 wherein said laser is a third harmonic laser.

54. The multiple pulse single head laser according to claim 1 further comprising an OPO generator for producing an output beam having a preselected frequency.